Certain Death at an Uncertain Time: The Decision to Sell Life Insurance

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8 May 2001

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We are grateful to the National Institute on Aging for financial support. We thank Alan Garber, Victor Fuchs, William Vogt, and seminar participants at Stanford University for their comments. We especially thank Dan Kessler for a close reading of an earlier version of the paper and for pointing out an egregious error in that version. We are responsible for all remaining errors.

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Abstract

We develop a model of the market for cashing out life insurance and test for asymmetric information using data on HIV patients. In symmetric information the probability of cashing out increases with (1) worsening health, (2) increasing non-liquid assets for sicker patients, decreasing non-liquid assets for healthier patients, and (3) decreasing liquid assets. When patients have private information, equilibrium typically entails welfare loss for unhealthy patients. When firms have private information, patients infer their riskiness from price offers, and symmetric information outcomes are achieved. We find evidence consistent with symmetric information outcomes in the data.

1. The Viatical Settlements Market

A viatical settlement is the sale of a life insurance policy for immediate cash payment at a discount to face value. When a consumer viaticates, the settlement company becomes the sole beneficiary of the policy and collects the face value of the policy when the policyholder dies. Consumers considering whether to sell life insurance are often too frail to work—due to life-threatening illness—and may need funds to finance consumption, including medical treatment. Though their liquid assets may be insufficient to support their consumption, these consumers have the option to sell or borrow against their non-liquid assets, such as a house or life insurance, reducing bequests. Consequently, in this paper, we model the consumer's decision as one of how to finance consumption.

The viatical settlement industry emerged in the 1980s in response to the advent of AIDS, which at that time was almost always fatal. By 1991, an estimated $50 million of viatical settlements had been sold. The industry has grown rapidly, with $500 million in policies viaticated by 1995 and $1 billion in policies by 1998 (NVA, 1999). The discovery of effective medication for HIV infection appears not to have deterred growth. Companies are expanding their business and some have started marketing viatical settlements to the elderly and patients with other terminal illnesses. In addition, twice as many life insurance policies now include accelerated deaths benefits as a feature than a decade ago (ACLI, 1999).

This paper is the first systematic study of this market. We develop a partial equilibrium model of the viatical settlements market and test for the presence of asymmetric information using a unique longitudinal database on patients receiving care for HIV. As in all markets for mortality contingent contracts, viatical settlement firms need to know the health of consumers to construct price offers that at least break even. The question then arises whether consumers or firms have private information about consumer health. Some evidence comes from other markets. For example, Mitchell *et al.* (1997) calculate the expected net present value of annuity contracts relative to premiums. They find that annuity contracts deliver payouts that are valued between 80% and 85% of premium costs, and are thus less attractively priced than are Treasury bonds. They conclude that their evidence is consistent with the inability of annuity firms to accurately observe mortality risk.

On the other hand, Cawley and Philipson (1999) find no evidence of asymmetric information in the term life insurance market. Their story follows Rothschild and Stiglitz (1976). They test two predictions about separating equilibria from this model—the unit price of insurance should rise with quantity purchased and the quantity purchased should be positively correlated with risk. In fact, their empirical findings contradict these predictions. Term life insurance markets display bulk price discounting and a negative covariance between risk and quantity. They conjecture that "sellers may know their costs of production better than consumers in this market, as in those for most other products." This paper pursues a similar approach, but the theoretical and empirical implications are very different for viatical settlements.

The results from this paper could have important implications for this relatively unregulated industry. Regulation at the federal level—through the 1996 Health Insurance Portability and Accountability Act—exempts viatical settlements from federal income tax if the consumer has a life expectancy of less than two years, or if the consumer is chronically ill and cannot perform at least two activities associated with daily living (HIPAA, 1996). If viatical settlement and credit markets are substitutes and loan receipts are tax free, then these tax provisions simply level the field for viatical settlements. Unlike other types of life insurance, there is minimal state regulation. This probably reflects the nascent status of the industry, rather than any beliefs by state regulators about the efficiency of the market. The possible existence of asymmetric information regarding life expectancy, and other determinants of settlement price, lead naturally to potentially welfare-enhancing regulation, such as requiring companies to report actuarial values of life insurance plans to customers.

2. A Partial Equilibrium Model of the Viatical Settlements Market

This section presents a simple partial equilibrium model of the decision to sell life insurance for consumers nearing the end of life. Consumers hold three distinct assets: a life insurance policy, other non-liquid assets, and liquid assets. They can finance consumption in three ways. They can consume liquid assets directly, they can borrow against other non-liquid assets at a given interest rate *r*, or they can sell part or all of their life insurance policy at a price *p* per dollar of coverage. Each action has costs in terms of foregone bequests. Liquid assets once spent cannot be bequeathed, loans must be repaid, and heirs cannot collect on life insurance that has been sold. We hypothesize that patients nearing the end of life solve a static optimization problem of distributing wealth between consumption and bequests to maximize utility[1]; in particular, such consumers do not discount bequests.[2] Firms, on the other hand, live forever and are risk neutral and thus discount future income at the market rate of interest.[3] This simple model generates sharp predictions that we can test with the available data.

Figure 1 represents a consumer's budget constraint when terms on the viatical settlement market are more favorable than terms on the credit market.[4] The vertical axis represents consumption, the horizontal axis represents bequests, and *W* represents the initial endowment, $\left(L, NL+\overline{F}\right)$. L is liquid assets, *NL* is non-liquid assets, and $\overline{F}$ is the face value of the life insurance policy. B represents the net present value of the endowment—$L + p\overline{F} + \frac{NL}{1+r}$— where consumers leave no bequests. Selling all of $\overline{F}$ moves consumers from W to A, where consumers have only non-liquid assets left to fund bequests. To increase consumption past A, consumers must turn to the credit market, where they borrow at interest rate *r*, represented by the line AB.

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[1] We also abstract away from consumers who are not 'cash-constrained'—i.e., those who save liquid assets to finance future consumption or bequests—because such individuals would never be interested in viaticating.
[2] This assumption is similar to one made by Abel (1986), also in the context of consumers near the end of life.
[3] Ours is a partial equilibrium approach because we do not specify how market interest rates are set.
[4] In this paper, we abstract away from premium payments as a feature of life insurance contracts. We can do this without any loss of generality, since liquid assets can be viewed as net of life insurance premiums.

Alternatively, consumers could borrow first and then sell their life insurance after their credit is exhausted. WCB is the budget constraint for this strategy, where C represents the exhaustion of non-liquid asset collateral and B represents the sale of $\overline{F}$ as well. By assumption in Figure 1, terms of trade favor the viatical settlements market; the slope of WA is greater (in absolute value) than the slope of WC. Therefore, consumers will viaticate first and then borrow only if $p\overline{F}$ is insufficient to finance consumption.

2.1 Effect of Mortality Risk on the Size of the Settlement

In our model, non-liquid assets and life insurance policies are essentially the same good, yet with distinct prices. Both can be used for exactly two purposes—to finance consumption, or to finance bequests. In an economy with homogenous consumers, the rates offered in the viatical settlements and credit markets will be equal in equilibrium, or else there would be arbitrage opportunities.

However, because price offers from viatical settlement firms depend on life expectancy, heterogeneous consumers will not face equal terms of trade. Even for life insurance policies with the same face value, firms will pay higher prices to consumers closer the end of life since firms are more likely to collect earlier. The viatical settlement price trades off against a market interest rate that is the same for everyone.

Let a_i reflect consumer i's risk of death, and let $H_1 = \{i \mid a_i < \overline{a}\}$, $H_2 = \{i \mid a_i = \overline{a}\}$, and $H_3 = \{i \mid a_i > \overline{a}\}$ for some cutoff level $\overline{a}$ so that H_1 consists of healthier consumers than H_3. We choose a cutoff value $\overline{a}$ such that for consumers in H_2, the cost of financing consumption through the credit and viatical settlement markets is equal. For H_1 consumers, the credit market offers lower prices, while for H_3 consumers, the viatical settlements market is more lucrative. We ignore H_2 consumers because the comparative statics results for them are indeterminate and because—for continuous distributions of population health—the size of the H_2 set is measure zero.

The Healthiest Consumers

Healthy consumers will first participate in the credit markets; and—if demand for consumption is strong enough—also in the viatical settlements market. Figure 2a demonstrates how H_1 consumers who do not initially sell life insurance respond to a health shock (an increase in a_i). These consumers face the concave budget constraint WCB and pick E as their optimum point. A small health shock, say $h_i > 0$, leads to a small increase in the viatical settlement price, represented by a move from B to B_1. Despite the health shock, the credit market continues to offer better terms than the viatical settlement market, there is no movement in the operative part of the budget constraint, and consumers continue to choose point E. However, if consumers experience a large enough health shock such that $h_i + a_i > \overline{a}$, the viatical settlements market will become more attractive. The terms of trade shift in favor of viaticating first, and the budget constraint becomes WAB_2. Consumers will move to point E', and will now participate in the viatical settlements market before they borrow at all.

Figure 2b considers the effect of health shocks on H_1 consumers who participate in both markets. These consumers borrow fully against *NL* and at least partly sell $\overline{F}$. The effect of a small health shock can be decomposed into income and substitution effects.[5] An adverse shock implies a higher unit price (say p_2) from the life insurance sale than before (say p_1). Holding all else fixed, the terms of trade after the shock make the viatical settlements market more attractive than before; this is the substitution effect. The income effect arises because a higher price raises the net present value of the endowment from $L + p_1\overline{F} + \frac{NL}{1+r}$ to $L + p_2\overline{F} + \frac{NL}{1+r}$. If bequests are a normal good, then the pure income effect from the health shock will induce the consumer to sell a smaller part of $\overline{F}$. Thus, the income and substitution effects from an increase in a_i oppose each other.[6]

[5] Large health shocks have effects similar to those described in the previous paragraph.

[6] We do not consider the case where bequests are an inferior good here. In that case, income and substitution effects reinforce each other.

Figure 2b presumes the income effect exceeds the substitution effect. Consumers move from E to E' when mortality risk changes from a_i to $a_i + h_i$, and viaticate a smaller part of their life insurance. The pure income effect is the move from E to E'', while the Hicksian substitution effect is the move from E'' to E'. *A priori*, however, we cannot rule out the possibility that the substitution effect dominates the income effect. If that were true, then increasing a_i would lead to the sale of a larger part of $\overline{F}$.

The Least Healthy Consumers

For the least healthy H_3 consumers, negative health shocks cannot make borrowing more attractive than viatical settlements. In Figure 3, consumers initially choose E, on the upper part of the budget constraint. Consumers sell their life insurance $\overline{F}$, and partially borrow against *NL*. The health shock shifts out the budget line from WAB to WA'B'. Because the interest rate is fixed, AB is parallel to A'B'. The effect of a health shock on bequests depends on the relative strengths of the income and substitution effects. At the new equilibrium E', the substitution effect dominates the income effect by a large amount and bequests decrease. Alternatively, if the income effect dominates, bequests would increase. For small health shocks life insurance supply would be unchanged. When the optimal choice lies on the lower part of the budget constraint, the effect of a health shock depends upon the relative strengths of the income and substitution effects, which typically move in opposite directions.

2.2 Effect of Assets on the Size of the Settlement

Changes in liquid and non-liquid assets lead to a parallel shift in the consumer's budget line and do not affect the terms of trade in the two markets. Increasing non-liquid assets raises both the value of the endowment and maximum possible bequests, since consumers either leave additional non-liquid assets as bequests or use them for borrowing. Increasing liquid assets raises the value of the consumer's endowment but does not change maximum possible bequests, $NL + \overline{F}$.

Non-liquid Assets

An increase in non-liquid assets increases the maximum size of bequests. For healthy H_1 consumers, these additional assets will induce them to substitute borrowing for life insurance sales, since the former is on more favorable terms. Figure 4a shows this effect. H_1 consumers initially borrow fully against their non-liquid assets and also sell life insurance at E. Increasing *NL* shifts the budget line from WAB to W'A'B'. At E', consumers have completely substituted borrowing for viaticating.[7]

For sicker H_3 consumers, the additional non-liquid assets can induce more life insurance sales. Figure 4b demonstrates the effect of an increase in *NL* for H_3 consumers who do not participate in the credit market and sell part of their life insurance. For these consumers, terms of trade favor the viatical settlements market. If consumption is a normal good, an increase in *NL* leads these consumers to sell a larger part of $\overline{F}$, as they can use the additional non-liquid assets to finance bequests. At G' on the new budget constraint, consumers sell the same amount of life insurance as at their initial optimum, E. Thus, the new equilibrium will lie on C'G', where consumers sell a larger part of $\overline{F}$ than at E.

Liquid Assets

Increasing liquid assets leads to a parallel shift in the consumer's budget constraint. Consumers use additional liquid assets to either finance increased consumption or to increase bequests by substituting for viatication or borrowing. If bequests are a normal good, increasing liquid assets will cause consumers to decrease their supply of life insurance, decrease their borrowing, or both. For H_1 consumers who do not initially sell life insurance, increasing liquid assets will reduce borrowing but have no effect on life insurance supply. For H_3 consumers who sell all of their life insurance and also borrow, the effects of increasing *L* depend upon the strength of the income effect. If the income effect is strong, consumers eliminate borrowing and reduce their supply of life insurance. If the income effect is weak,

[7] For H_1 consumers with an initial optimum in the lower part of the budget constraint, an increase in *NL* will have no effect on the supply of life insurance.

consumers continue to sell all of $\overline{F}$, but reduce borrowing. Hence, for H_3 consumers, increasing liquid assets will never increase the supply of life insurance.

2.3 Summary of Predictions

The model makes several sharp predictions regarding the behavior of consumers in the viatical settlement and credit markets. The first three are empirically testable with our data, the fourth is not.

Prediction 1. *Health status is negatively correlated with the decision to viaticate.*

This prediction follows directly from Figure 1. Healthy H_1 consumers prefer credit markets first; whereas unhealthy H_3 consumers prefer to sell life insurance. This heterogeneity arises because the price of life insurance reflects the underlying mortality risk of consumers, whereas borrowing occurs at a market rate.

Prediction 2. *For the healthiest consumers, the decision to viaticate is negatively correlated with non-liquid assets. For the sickest, the decision to viaticate is positively correlated with non-liquid assets.*

This follows from Figures 4a and 4b and is a rather stringent test of the model. It requires that the impact of non-liquid assets on the decision to viaticate in our empirical specification have different signs depending on the underlying health status of the consumer.

Prediction 3. *For all consumers, a small increase in liquid assets will either reduce or leave unchanged the incentive to participate in the viatical settlements market.*

Thus, it would constitute evidence against our model if we observe that HIV patients with higher liquid assets (before viaticating) are more likely to viaticate than are patients with lower liquid assets. A measured zero or negative correlation between the decision to viaticate (or borrowing) and amount of liquid assets, all else remaining the same, would be consistent with the predictions of our model.

Prediction 4. *For H_1 consumers who participate in the credit market only, it takes a large negative health shock (enough to move the consumer from H_1 to H_3) to induce participation in the viatical settlements market. For H_3 consumers, the effects of health shocks on the incentive to viaticate is ambiguous and depend upon the relative strengths of the income and substitution effects.*

This explains why only consumers who have suffered a large negative health shock since the purchase of their life insurance policy, such as HIV patients and the chronically ill elderly, sell life insurance. Taken together these predictions are consistent with a backward bending supply curve of viatical settlements. For relatively healthy consumers, they imply a positive longitudinal correlation between negative health shocks and the decision to viaticate. For unhealthy consumers, the effect of a health shock is ambiguous and a negative health shock might actually reduce the incentive to viaticate.

3. Asymmetric Information in the Viatical Settlements Market

Up to now we have assumed that all parties observe the health status of consumers in a viatical settlement. Under these circumstances, firms write contracts that depend upon a, and the equilibrium unit price P that each consumer faces will be the actuarially fair unit price *for that consumer*. In this section, we relax this assumption, and posit that consumers know a, but that viatical settlement firms do not. In equilibrium contracts, price cannot depend upon a but may depend upon F.[8] The most plausible asymmetric information equilibria share the feature that unhealthier consumers are less likely to participate in the viatical settlements market.

We also consider a model where the direction of asymmetric information is reversed and posit that firms know more about the health status of consumers than consumers themselves. This may be plausible in the viatical settlements market because firms have full access to the health records of potential clients, and have at their disposal sophisticated medical personnel to help interpret these charts. We find that the equilibrium under these informational conditions is identical to the symmetric information equilibrium.

3.1 Consumers Have Private Information

Our model of asymmetric information follows Rothschild and Stiglitz (1976) and Wilson (1977) but differs in three important ways. First, because consumers are sellers rather than buyers in the viatical settlements market, low mortality risk implies a higher risk for firms of delayed life insurance payout. To avoid confusion and to maintain consistency with the literature on insurance, we adopt the convention of discussing risk from the buyer's point of view. In this section we use "low risk" interchangeably with high mortality risk and "high risk" interchangeably with low mortality risk.

Second, unlike traditional insurance markets where consumers who face actuarially fair premiums fully insure, in our model equilibrium life insurance sales depend on consumer risk type. In symmetric information equilibrium, increasing risk (that is, reducing a) has an ambiguous effect on optimal life insurance sales.

Third, in the Rothschild-Stiglitz-Wilson analysis, for any given endowment, high risk types value increases in income in case of accidents more than do low risk types. That is, high risk indifference curves always cut low risk indifference curves from below, which makes sense because high risk types are more likely to have accidents in the first place.[9] In our model, we need not place any restrictions on the direction of indifference curve crossing though we maintain, as they do, that the indifference curves of high and low risk types cross exactly once. On the one hand, higher risk of death (poorer health status) may increase the demand for medical care. If this is true, then high risk types will always be willing to trade away more in bequests in exchange for an extra unit of consumption than will low-risk types, which in turn implies that high risk indifference curves cut low risk curves from above. On the other hand, due to their infirmity, the unhealthy may derive less utility per unit of consumption than the healthy. In this case, high risk indifference curves cut low risk curves from below.[10]

The population consists of exactly two types: high risk consumers who have probability a_L of dying and low risk consumers who have probability a_H of dying ($a_H > a_L$). The two types of consumers are similar in all other aspects. Let q and 1-q be the proportions of high and low risk types respectively

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[8]This dependence of P on F may be nonlinear. Cawley and Philipson (1999) argue that under asymmetric information, equilibria must be non-linear with more than linearly higher unit prices assigned to higher volume contracts.

[9]In the Rothschild-Stiglitz-Wilson analysis, income in the case of no accidents is plotted on the horizontal axis, while income in the case of an accident is plotted on the vertical axis.

in the population so that $\bar{a} = qa_L + (1-q)a_H$ is the average mortality risk. Firms can compete in both quantity and prices, so a viatical settlement contract (P, F) will specify both the price the firm is willing to pay and the quantity of life insurance it will buy at that price. We assume that a consumer cannot split a life insurance policy and sell parts to two different firms. Free entry and perfect competition ensure that contracts sold in equilibrium make zero expected profits. Thus, in equilibrium, consumers maximize expected utility, firms make zero profits, and no contract outside equilibrium makes non-negative expected profits for firms.

No Pooling Equilibrium

A pooling equilibrium is a singleton contract set where both risk types trade the same contract in equilibrium. Clearly this contract must be on the market zero profit line. Despite the fact that both risk types face the same price, expected utility maximizing supply of life insurance will differ on this line because of the assumption that high and low risk indifference curves must cross. Rothschild and Stiglitz (1976) and Wilson (1977) show that any potential pooling equilibrium can be broken by an offer that attracts low risk types only, if the indifference curves of high and low risk consumers cross. This analysis applies directly to our context.

The Possible Existence of Separating Equilibria

Figures 5a and 5b demonstrate the possible existence of separating equilibria—that is, an equilibrium contract set that consists of two contracts, one attracting low risk types and the other attracting high risk types. For a separating equilibrium to exist, one of the offered contracts must lie on the high risk zero profit line (*WC*), while the other must lie on the low risk zero profit line (*WB*). The difference between Figures 5a and 5b arises from different assumptions about the direction of

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[10] In the symmetric information model, we abstract away from the effect that changing mortality risk has on preferences, since to derive our results it is sufficient to assume that changing mortality risks affects the budget

indifference curve crossing. The former assumes low risk indifference curves cut those of the high risk types from above, while the latter assumes the opposite.

In Figure 5a, firms offer a pair of contracts $\theta_H = (P_H, \alpha_H)$ and $\theta_L = (P_L, \alpha_L)$. The high risk indifference curve, U_H, is tangent to the high risk zero profit line at α_H and intersects the low risk zero profit line at α_L. Because low risk indifference curves cut those of the high risk types from above α_H must be to the left of α_L. Clearly, high risk types are indifferent between α_H and α_L, while low risk types prefer α_L to α_H. Also, α_H is the same point that high risk types would choose under symmetric information, so no firm can make positive profits by offering high risk types a better deal.

The optimum point, γ_L, for low risk types on their zero profit line lies between α_L and *B*. Now, α_L is the best contract that can be offered to the low risk types without attracting high risk types (and making negative profits). Therefore, $\{\theta_L, \theta_H\}$ is a potential separating equilibrium where high risk types impose a negative externality on low risk types who are unable to obtain utility U_L.[11]

If γ_L lies between α_L and *W*, then U'_L slopes below the low risk zero profit line to the right of α_L. In that case, $\{\theta'_L = (P_L, \gamma_L), \theta_H\}$ is a separating equilibrium where both high and low risk types attain their symmetric equilibrium outcomes and there is no negative externality. This case holds when there is a large income effect. It constitutes a departure from the Rothschild-Stiglitz-Wilson analysis.

In Figure 5b, low risk indifference curves cut those of the high risk types from below. As before, the candidate equilibrium set consists of a contract pair, $\{\theta_H = (P_H, \alpha_H), \theta_L = (P_L, \alpha_L)\}$, with the high risk indifference curve tangent to the high risk zero profit line at α_H and intersecting the low risk zero profit line at α_L, but now the low risk indifference curves cut those of the high risk types from *below*. θ_L is now the *upper* intersection point between U_H and the low risk zero profit line, so that α_H is

constraint only.

[11]There are conditions under which $\{\theta_L, \theta_H\}$ will not be a separating equilibrium that depend upon the relative proportions of high and low risk types in the market. See Rothschild and Stiglitz (1976) or Wilson (1977).

to the right of α_L. If the symmetric information optimum for low risk types, γ_L, lies between α_L and *W*, then $\{\theta_L, \theta_H\}$ is a possible separating equilibrium with the same negative externality imposed upon low risk types. If γ_L lies between α_L and *B*, then $\{\theta'_L = (P_L, \gamma_L), \theta_H\}$ is a separating equilibrium with no negative externality. Finally, if upper intersection point of U_H and the low risk zero profit line (*WBA*) is to the left of *NL*, the equilibrium contract set reverts to $\{\theta_H, (P_L, \alpha'_L)\}$, where α'_L is the lower intersection point between U_H and *WBA*. Firms cannot make positive profits if they offer $\{\theta_H, (P_L, B)\}$, as both types would prefer (P_L, B), breaking the equilibrium.[12]

Under most plausible scenarios, asymmetric information leads to a negative externality for low risk types, hence they will be less likely to trade under asymmetric information than under symmetric information. However, we cannot *a priori* rule out symmetric information outcomes even under asymmetric information.

3.2 Viatical Settlement Firms Have Private Information

In this section, we continue to assume informational asymmetries, except now we posit that firms know more about consumer health than consumers do themselves. This may be more plausible in the viatical settlements industry than in other contexts. Viatical settlement firms employ doctors and actuaries who closely examine the medical charts of potential sellers before offers are made (see NVA, 1999). Even if consumers are well informed about their health, they may not have available accurate life tables to translate that information into a life expectancy projection. Thus, it is natural to consider how "reverse" asymmetric information might affect equilibrium outcomes.

Unlike before, firms have accurate information about consumer mortality risk, so they can accurately predict whether any particular policy will return (in expectation) positive, zero, or negative

[12]Firms cannot offer (P_L, α_L) in this case, as the most life insurance they can offer to buy is $\overline{F}$.

profits at a given price. Moreover, they can offer different prices to consumers of different risk types. Obviously, firms will not offer any consumer a price resulting in negative expected profits. If the price results in positive (or zero) expected profits from a viatical settlement with a consumer with mortality risk *a*, firms have no incentive to constrain the quantity of life insurance they buy from that consumer.

Under these informational constraints, consumers solve their maximization problem based on their *beliefs* about their own risk type, $\hat{a}$, rather than their actual risk type, *a*. Clearly consumer beliefs cannot depend on *a* but may depend on any other information available. Most importantly, they can use the price offers they receive as signals of their risk type. In a competitive market, price offers that are more generous than actuarially fair given beliefs are a signal that $\hat{a}$ is too high relative to the truth. On the other hand, price offers on terms that are less than actuarially fair given beliefs are a signal that $\hat{a}$ is too low relative to the truth. Let $P(a)$ be the actuarially fair price associated with mortality risk *a*. We say that $\hat{a}$ is consistent with a price offer, *P*, if and only if $P = P(a)$; that is, consumers believe that they are receiving the actuarially fair price.

A competitive equilibrium in the viatical settlements market is any set of triples $(P, F, \hat{a})$ of prices, quantity of life insurance sold, and beliefs about *a* that meets the following conditions:

(T1) Consumers choose quantity to maximize expected utility given prices and beliefs;
(T2) Firms make zero expected profits on the contracts in the equilibrium set;
(T3) No contract outside the equilibrium makes non-negative expected profits for firms; and
(T4) For each triple, consumer beliefs $\hat{a}$ are consistent with the equilibrium price *P*.

We next show that a competitive equilibrium exists in the viatical settlements market if and only if beliefs are accurate (that is, $\hat{a} = a$), prices are actuarially fair for the true mortality risk—$P = P(a)$—and *F* is a solution to the consumer's utility maximization problem given beliefs and prices (let F^* be such a solution). First, we show that the triple $(P = P(a), F = F^*, \hat{a} = a)$ is a competitive equilibrium. By definition, F^* satisfies condition (T1). If prices are actuarially fair, then firms make zero profits on all contracts, satisfying condition (T2). The only belief about mortality consistent with actuarially fair prices is $\hat{a} = a$. That is, $P(\hat{a}) = P(a)$ if and only if $\hat{a} = a$, which satisfies condition (T4). Finally, if firms make an offer higher than actuarially fair they will make negative profits, and if firms make an offer below actuarially fair no consumer will accept them, which confirms that condition (T3) is satisfied.

Next, we demonstrate that $(P(a), F^*, a)$ is the only possible competitive equilibrium. There are two potential ways that price offers by firms could be consistent with the zero profit condition (T2)—actuarially fair prices to all consumers or above actuarially fair prices to some consumers and below to others. The arbitrage argument in the previous paragraph rules out the latter possibility. That is price competition among firms ensures actuarially fair price offers in equilibrium. Finally, the argument in the previous paragraph regarding the consistency of beliefs and prices is sufficient to establish that given actuarially fair prices, $\hat{a} = a$ and $F = F^*$ is the only possible equilibrium.

Clearly, the initial information asymmetry in this market quickly dissipates as firms reveal their private information to consumers through prices. Hence a separating equilibrium in this situation is identical to the symmetric information equilibrium. All of the analysis of symmetric information equilibria apply directly with no further modifications.

4. Empirical Tests of the Model

To test the predictions of these models, we use data from the HIV Costs and Services Utilization Study (HCSUS), a nationally representative survey of HIV infected adults receiving care in the United States. This dataset is appropriate because it contains extensive information on a sample of terminally ill patients who constitute a large share of the viatical settlements market. Bozzette et al. (1998) describe the design of the data set, including sampling, in detail. Though HCSUS does not contain information about transactions prices and quantities in the viatical settlements market, we are nevertheless able to conduct some powerful tests.

4.1 Data

HCSUS is a panel study that followed the same set of patients over three interview waves. There were 2,864 respondents in the baseline survey, conducted between 1996 and 1997; 2,466 respondents in the first follow-up (FU1) survey, conducted in late 1997; and 2,267 respondents in the second follow-up (FU2) survey, conducted in 1998. The dataset has information on the respondents' demographics, income and assets, health status, life insurance, and participation in the viatical settlements market.

Questions about life insurance holdings and sales were asked in the FU1 and FU2 surveys but not in the baseline survey. Of the 2,466 respondents in FU1, 1,353 (54.7%) reported life insurance holdings. These 1,353 respondents are our analytic sample as they are the only patients at risk to viaticate. 344 of these respondents have missing values for at least one of the key variables—diagnosis date, health status, liquid assets, or non-liquid assets—so we exclude them, leaving 1,009 respondents. In our remaining analytic sample, 132 (13%) respondents had sold their life insurance by the FU1 interview date, and an additional 33 respondents sold their life insurance between the FU1 and FU2 interview dates.

Table 1 compares summary statics from the baseline interview of respondents who viaticated at some point in time with those who never did.[13] Viators are more likely than never-viators to be male, white, college-educated and older. They are also richer, with higher incomes and more liquid and non-liquid assets—including real estate holdings. Finally, viators are typically in poorer health than never-viators, with lower CD4 T-cell levels at the baseline survey and more progressive HIV disease.

4.2 The Hazard of Viaticating

Although HCSUS respondents report whether they sold their life insurance, they report neither the exact date of sale nor the quantity sold. Fortunately, because HCSUS respondents report whether they viaticated by FU1 and by FU2, we can determine the time at risk to viaticate. Given these data, we estimate an empirical model of the decision to viaticate that allows for time-varying covariates. Because we do not observe quantity sold, our focus is necessarily on the decision to sell at all.

There are three kinds of respondents—those who have viaticated by FU1, those who viaticated between FU1 and FU2, and those who never viaticate in the observation window. Each has a different contribution to the likelihood function. Let $\lambda(t)$ be the probability of not viaticating at time *t* given that the respondent has not viaticated in the preceding *t*-1 years. Time is measured starting from the year of diagnosis with HIV, or the viatical settlements market inception date—1988—whichever is earlier. The probability that a respondent never viaticated is $\prod_{t=1}^{T}\lambda(t)$, where T is years between the start and end of the observation window. Similarly the probability that a respondent viaticated by FU1 is $1-\prod_{t=1}^{T_1}\lambda(t)$ where T_1 is years between the start and the FU1 interview date. The probability that a respondent did not viaticate between the start date and FU1 but did viaticate by FU2 is $\prod_{t=1}^{T_1}\lambda(t)-\prod_{t=1}^{T_2}\lambda(t)$, where T_2 is years between the start and the FU2 interview date. Combining these three types of respondents gives the likelihood function:

(16) $$L=\prod_{i=1}^{N}\left\{D_{1i}\left[\prod_{t=1}^{T_1}\lambda_i(t)-\prod_{t=1}^{T_2}\lambda_i(t)\right]+D_{2i}\left[1-\prod_{t=1}^{T_1}\lambda_i(t)\right]+D_{3i}\left[\prod_{t=1}^{T}\lambda_i(t)\right]\right\}$$

where, *i* subscripts over the *N* respondents;
D_{1i} is a binary variable that indicates if respondent *i* viaticated between FU1 and FU2;
D_{2i} indicates if respondent *i* viaticated by FU1; and
D_{3i} indicates that respondent *i* never viaticated.

We model the hazard of not viaticating as,

(17) $$\lambda_i(t)=\frac{1}{1+\exp(\lambda_t^0+X_{it}\beta)},$$

[13] Including the 344 respondents who had at least one missing value has no appreciable effect on the summary

where X_{it} is a vector of covariates measured at time t, β is the vector of regression coefficients, and

$\frac{1}{1+\exp(\lambda_t^0)}$ is the baseline logit hazard rate. We maximize (16) to estimate the parameters λ_t^0 and β.

HCSUS respondents were interviewed at three discrete times. One major consequence of this sampling strategy is that we do not observe X_{it} at each point in time t, so we have no measures of patient health status or changes in assets between surveys. We use a step function approximation to impute values of X_{it}. For example, suppose a respondent is sampled at time points t_1, t_2, and t_3, and reports values for X_t of x_1, x_2, and x_3 at each of these time points respectively. We assign

$$X_t = \begin{cases} x_1 & \text{for } t \le t_1 \\ x_2 & \text{for } t_1 < t \le t_2 \\ x_3 & \text{for } t_2 < t \le t_3 \end{cases}$$

4.3 Measuring Health, Income, and Assets

We include as covariates demographics, health status, income, and a full set of interactions between non-liquid assets and health status. When HCSUS was conducted, the two most important health status measures for HIV patients were CD4+ T-lymphocyte cell count and the Center for Disease Control (CDC) definition of clinical stage. CD4+ T-cell count measures the function of a patient's immune system; depletion correlates strongly with worsening HIV disease and increasing risk of opportunistic infections (Fauci *et al*., 1998). While healthy patients have CD4 cell counts above 500 cells per ml., declines into lower clinically recognized ranges correlate with worsening disease. These ranges are: between 200 and 500 cells per ml., between 50 and 200 cells per ml., and below 50 cells per ml. There are three categories in CDC definition of clinical stage: asymptomatic, symptomatic, and AIDS (CDC, 1993). Patients have AIDS if they manifest conditions such as

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statistics that we report in Table 1.

Kaposi's Sarcoma, Toxoplasmosis, or the other life- threatening conditions on the CDC list. Symptomatic HIV+ patients manifest some conditions related to their infection, but not one of the AIDS defining conditions.

Ideally, we would like to classify HCSUS respondents into groups H_1 and H_3 that are based upon the actuarially fair price of insurance and upon health status. Unfortunately, because we do not observe transaction prices, this is impossible. Instead, we construct a one-dimensional indicator of mortality risk by regressing one-year mortality after the baseline survey on the two clinical health measures. This probit regression is shown in Table 2. As expected, respondents with lower CD4 T-cell levels or with more advanced disease are more likely to die. Using these results, we predict one-year mortality rates for each respondent at each time point when we have new CD4 T-cell levels and clinical stage indicators. Finally, we use a cutoff value of 0.04 for predicted mortality to divide our sample into respondents with high mortality risks (25% of respondents at baseline) and respondents with low mortality risk (75% of respondents at baseline). If the cutoff value we chose is correct, then the latter groups of respondents corresponds to H_1, while the former group of respondents corresponds to H_3. Based upon this division we create a dummy variable, *Unhealthy*, which is our main health status indicator. Because we do not know the true cutoff value (which is a function of the unobserved transaction price) we try different cut-off values for the health status indicator in other specifications to test the robustness of our results.

HCSUS queries respondents about the value of real estate, vehicles, and farm or business less any debt on these assets. Unfortunately, these comprehensive questions on non-liquid assets were only asked in the baseline survey, not in FU1 or FU2. We use house ownership as the measure of non-liquid assets as it was asked in all three surveys. Respondents who owned a house at baseline reported having higher non-liquid assets as compared to respondents who did not own a house at baseline ($66,740 vs. $25,832). We designate the indicators for house ownership and non-ownership as *House* and *NoHouse*, respectively.

Similarly, HCSUS queries respondents about savings, checking, money market, stocks, fixed deposits, IRA and other financial assets. Like non-liquid assets, this detailed measure of liquid assets was assessed only in the baseline survey. Accordingly, we use income which was asked in each interview as a measure of liquid assets. In any case, income is a better measure of the liquid assets construct in our theoretical model because income can be used to finance consumption at no extra cost while some of the other financials assets (such as IRAs and fixed deposits) might not be available for consumption or would require additional liquidation costs. Because many HCSUS respondents only report their income within ranges, we enter income in our models as a series of indicator variables: 1(*Income* < \$500 per month), 1(\$501 ≤ *Income* < \$2,000), and 1(*Income* ≥ \$2,000).

4.4 Hypotheses

Table 3 maps the predictions from the symmetric and asymmetric information models into testable hypotheses. To test these hypotheses, we include in the model interactions between health status (*Unhealthy*) and house ownership (*House*). The first prediction implies that—with symmetric information—the hazard of viaticating should be higher for the unhealthy, regardless of home ownership.

Prediction 2 is a stringent test of the model, since it implies that the impact of home ownership among the healthy should have the opposite effect that it has the unhealthy. For the unhealthy, home ownership should increase the probability of viaticating; for the healthy, it should reduce it. Prediction 3 requires consumers with high incomes to be less likely to viaticate to finance consumption.

On the other hand, if the market is characterized by informational asymmetry with welfare loss for the unhealthy, then Prediction 1 should be reversed. In this case, the presence of healthy patients (high risk types) in the market imposes a negative externality on unhealthy patients. Intuitively, this externality should reduce the probability of participation by the unhealthy in the viatical settlements market, since they can avail themselves of the credit market instead to avoid quantity restrictions.

4.5 Results

Table 4 reports the average hazard ratios at $t = 1$ and baseline hazard rates for five different specifications of the empirical model in section 5.2. We average the hazard ratios for each covariate across all individuals in the sample as they depend not only on the regression coefficient associated with the covariate but also on the values of the other covariates. The appendix specifies our methodology for computing the hazard ratios and their standard errors.

The second column (Model 1) in Table 4 reports the results for the simplest empirical model needed to test the empirical hypothesis presented in Table 3. Healthy consumers with houses have the lowest viatication hazards. Healthy consumers without houses are 1.7 times more likely to viaticate at $t = 1$ year than healthy house owners, unhealthy consumers without houses are 2.4 times more likely, while unhealthy consumers who own a house are 3.9 times more likely. Figure 6 plots the predicted survivor functions—i.e., cumulative probability of <u>not</u> viaticating—implied by the results in Model 1 for each house ownership and health group from $t = 1$ year to $t = 9$ years. It clearly demonstrates an ordering of viatication hazards that are consistent with symmetric information equilibrium. In particular, we reject that any of four hypotheses relating to Predictions 1 and 2 are false. Income has no statistically significant effect on viatication probabilities, which is weak evidence in favor of Prediction 3.

Models 2 and 3 in Table 4 add demographic and education variables to Model 1. Whites have significantly higher hazards of viaticating than do blacks, Hispanics, and respondents of other races, and older respondents are significantly more likely to viaticate. There are no statistically significant differences among high school dropouts, high school graduates and college educated respondents in viatication hazards, though the point estimates indicate college graduates and those with some college education are more likely to viaticate. As was true in Model 1, the results of these models conform to the predictions in Table 3 and are thus consistent with symmetric information equilibrium.

In Models 4 and 5, we check the robustness of our results to a change in the definition of health status. In particular, instead of a cutoff value of 0.04 for predicted mortality, we use a value of 0.012 to divide our sample into unhealthy (50% of respondents at baseline) and healthy respondents (50% of respondents at baseline). Except for the change in definition of health status, Models 5 and 6 are identical to Models 1 and 2 respectively. As was the case with Models 1 and 2, in Models 5 and 6 we reject the hypotheses that Predictions 1, 2b and 3 are false. We find that among the unhealthy, those with houses are more likely to viaticate than those without, which is consistent with Predictions 2a, but this difference is not statistically significant.

In summary, we find no evidence of adverse selection in the viatical settlements market. Symmetric information best explains our empirical results. Predictions about the impact of health status and non-liquid assets (Predictions 1 and 2) are most robust. Evidence for the impact of liquid assets is weaker.

5. Conclusion

The principal contribution of this paper is to test empirically for the presence of adverse selection in an emerging mortality contingent "reverse" insurance market. We develop a model to evaluate outcomes in this market under different informational assumptions. Our primary theoretical finding is that even symmetric information equilibria may feature a positive correlation between risks and quantity, when income effects dominate substitution effects. This result contrasts with Cawley and Philipson (1999), who argue that "when underwriting is costless and there is no state-dependence in consumption, all risks are priced out fairly and everyone fully insures after underwriting[, which] implies a zero covariance between quantity and risk." In their setting, this result is not surprising because there are no income effects.

To analyze the effects of asymmetric information we consider a modified version of the Rothschild and Stiglitz (1976) framework, which we link to the symmetric information model. When consumers know more than firms about risks, we continue to find that pooling equilibria are impossible, and that the typical separating equilibrium exhibits a welfare loss for low risk types. However, we also find separating equilibria that exhibit symmetric information outcomes with no welfare loss. When firms initially know more than consumers, as long as there is competition, consumers infer their riskiness from price offers, the informational asymmetry unravels, and symmetric information outcomes are achieved.

Using a unique longitudinal data set of HIV infected patients, we find evidence consistent with symmetric information outcomes. Specifically, our symmetric information model predicts (1) sicker patients should be *more* likely to viaticate, (2) among sicker patients those with significant non-liquid assets should be *more* likely to viaticate, and (3) among healthier patients those with significant non-liquid assets should be *less* likely to viaticate. Our empirical findings strongly confirm all of these predictions. While these results are not sufficient to rule out asymmetric information in the viatical settlements market, we can rule out welfare loss arising from informational asymmetries.

Our results have at least three direct policy implications. First, there is no reason to believe that requiring companies to report the actuarial value of life insurance plans to customers would have any welfare enhancing effects. Privacy considerations should not induce state regulators to limit access to the medical records of potential viators. Second, our model justifies the exemption of viatical settlements from federal income taxes. Because viatical settlements are similar to borrowing against non-liquid assets, and because loan receipts are not taxed, viatical settlements should be given the same exemption to preserve tax equity. Finally, our model can be extended to analyze other proposed and existing regulation on viatical settlements, such as minimum price floors and licensing requirements.

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Table 1: Demographics at Baseline of Viators vs. Non-viators

Variables	Entire sample with life insurance (N = 1,009)	Ever sold life insurance (N=165)	Never sold life insurance (N=844)
Age	35	37	35
Male	81.46%	87.8%	80.21%
White	59%	78%	56%
Black	24.47%	16.36%	26.06%
Hispanic	10.50%	4.8%	11.61%
Have college degree	25.94%	33.39%	26%
Monthly Income			
< $500	15.36%	12.72%	15.87%
$501 - $2000	40.53%	41.21%	40.40%
> $2000	44.11%	46.07%	43.73%
Liquid assets			
< $5,000	72.15%	64.84%	73.57%
$5,001 - $25,000	13.28%	15.75%	12.79%
> $25,000	14.57%	19.41%	13.64%
House ownership	31.81%	34.54%	31.27%
Non-liquid assets:			
< $10,000	69.37%	60.60%	71.09%
$10,001 - $50,000	13.57%	19.39%	12.44%
$50,001 - $200,000	11.10%	12.12%	10.90%
> $200,000	5.96%	7.89%	5.57%
Disease Stage:			
Asymptomatic	9.41%	9.01%	9.47%
Symptomatic	51.14%	37.5%	53.79%
AIDS	39.44%	53.49%	36.74%
CD4 T-cell levels:			
< 50 cells per ml	11.79%	14.54%	11.25%
50 – 200 cells per ml	25.07%	41.21%	21.91%
201 – 500 cells per ml	41.82%	31.51%	43.83%
> 500 cells per ml	21.32%	12.74%	23.01%

Table 2: One-Year Mortality Probit Regression

Variable	Coefficient	Standard Error
CD4 T-cell < 50	1.40	0.39
CD4 T-cell 51-200	0.50	0.39
CD4 T-cell 201-500	0.32	0.38
CD4 T-cell 500+*	-	
Asymptomatic	-0.51	0.47
Symptomatic	-0.41	0.22
AIDS*	-	
Intercept	-2.25	0.38
N		
Log Likelihood		

* Reference categories

Table 3: Hypotheses

Prediction	**Test**[†]
<u>Symmetric Information</u> Prediction 1: Negative correlation between health status and the decision to viaticate.	$\lambda(t\|Unhealthy, House) > \lambda(t\|Healthy, House)$ $\lambda(t\|Unhealthy, NoHouse) > \lambda(t\|Healthy, NoHouse)$
Prediction 2a: Among healthy consumers, negative correlation between the decision to viaticate and the amount of non-liquid assets	$\lambda(t\|Healthy, House) < \lambda(t\|Healthy, No\ House)$
Prediction 2b: Among unhealthy consumers, a positive correlation between the decision to viaticate and the amount of non-liquid assets	$\lambda(t\|Unhealthy, House) > \lambda(t\|Unhealthy, No\ House)$
Prediction 3: Zero or negative correlation between liquid assets and the decision to viaticate	$\lambda(t\|Income\ \$2000+) \leq \lambda(t\|Income\ \$500\text{ to }\$2000)$ $\leq \lambda(t\|Income\text{ below }\$500)$
<u>Asymmetric information</u> Equilibrium with welfare loss for the unhealthy	$\lambda(t\|Unhealthy, House) < \lambda(t\|Healthy, House)$ $\lambda(t\|Unhealthy, NoHouse) < \lambda(t\|Healthy, NoHouse)$

† $\lambda(t|\cdot)$ is the hazard of viaticating at time t.

Table 4: Results of empirical models of the hazard of viatication

Variables	Model 1 Haz. Ratio (s.e.)	Model 2 Haz. Ratio (s.e.)	Model 3 Haz. Ratio (s.e.)	Model 4 Haz. Ratio (s.e.)	Model 5 Haz. Ratio (s.e.)
Male	- -	1.15 (0.28)	1.08 (0.27)	- -	1.18 (0.28)
Black#	- -	0.63 (0.11)	0.64 (0.12)	- -	0.66 (0.12)
Hispanic#	- -	0.35 (0.11)	0.35 (0.12)	- -	0.35 (0.12)
Other Race#	- -	0.48 (0.22)	0.51 (0.24)	- -	0.54 (0.24)
Age	- -	1.19 (0.05)	1.18 (0.05)	- -	1.19 (0.05)
High School°	- -	- -	0.79 (0.23)	- -	- -
Some College°	- -	- -	1.52 (0.39)	- -	- -
College °	- -	- -	1.49 (0.40)	- -	- -
Income \$500 –2000‡	1.01 (0.23)	0.87 (0.21)	0.82 (0.20)	0.98 (0.21)	0.87 (0.20)
Income > \$2000‡	1.37 (0.30)	1.16 (0.29)	1.02 (0.25)	1.32 (0.28)	1.16 (0.27)
Unhealthy*House†	3.90 (0.95)	4.39 (1.14)	4.23 (1.13)	2.54 (0.65)	2.86 (0.78)
Unhealthy *NoHouse †	2.37 (0.58)	2.86 (0.73)	2.82 (0.73)	2.28 (0.57)	2.82 (0.74)
Healthy*NoHouse †	1.70 (0.38)	2.08 (0.48)	2.00 (0.47)	1.45 (0.38)	1.86 (0.51)
$1/\left(1+\exp\left(\lambda_1^0\right)\right)$	0.072 (0.032)	0.020 (0.015)	0.021 (0.017)	0.082 (0.037)	0.020 (0.014)
$1/\left(1+\exp\left(\lambda_2^0\right)\right)$	0.046 (0.016)	0.014 (0.009)	0.015 (0.011)	0.049 (0.019)	0.013 (0.008)
$1/\left(1+\exp\left(\lambda_3^0\right)\right)$	0.027 (0.010)	0.008 (0.005)	0.009 (0.007)	0.026 (0.010)	0.006 (0.004)
$1/\left(1+\exp\left(\lambda_4^0\right)\right)$	0.019 (0.007)	0.006 (0.003)	0.007 (0.005)	0.020 (0.008)	0.005 (0.004)
$1/\left(1+\exp\left(\lambda_5^0\right)\right)$	0.018 (0.007)	0.005 (0.003)	0.006 (0.004)	0.021 (0.008)	0.005 (0.003)
$1/\left(1+\exp\left(\lambda_6^0\right)\right)$	0.018 (0.007)	0.005 (0.003)	0.006 (0.004)	0.018 (0.006)	0.005 (0.003)
$1/\left(1+\exp\left(\lambda_7^0\right)\right)$	0.012 (0.005)	0.004 (0.002)	0.004 (0.003)	0.013 (0.006)	0.003 (0.002)
$1/\left(1+\exp\left(\lambda_8^0\right)\right)$	0.017 (0.006)	0.005 (0.003)	0.005 (0.003)	0.017 (0.006)	0.004 (0.002)
$1/\left(1+\exp\left(\lambda_9^0\right)\right)$	0.006 (0.002)	0.002 (0.001)	0.002 (0.001)	0.006 (0.002)	0.001 (0.001)

Reference Category: White; † Reference Category: Healthy*House;

‡ Reference Category: Income < \$500; ° Reference Category: No High School

Appendix: Monte Carlo Computation of Hazard Ratios

We use Monte Carlo simulations to calculate the hazard ratios, hazard rates and standard errors reported in Table 4. Let $\mu_{est} = \begin{pmatrix} \beta_{est} \\ \lambda^0_{est} \end{pmatrix}$ be the maximum likelihood estimates of $\beta = (\beta_1, \beta_2, \ldots\ldots\beta_k)$ (where k is the number of covariates) and $\lambda^0 = (\lambda^0_1, \lambda^0_2, \ldots\ldots\lambda^0_9)$ from equation (17), and let $\sum_{est}$ be the estimated variance covariance matrix of μ, which is asymptotically distributed multivariate normal.

In each iteration of the Monte Carlo simulation, we draw a random vector of regression coefficients, $\mu^{(i)} = (\beta^{(i)}, \lambda^{0(i)})$ from $N(\mu_{est}, \Sigma_{est})$, where i indexes over the iterations. Using this randomly drawn $\mu^{(i)}$ we calculate an average hazard ratio for each dichotomous covariate:

(A2-1) $$hazard\ ratio_{i,k} = \frac{1}{N}\sum_{j=1}^{N}\frac{1-\lambda_j(1 \mid X_k = 1, X_{k+1} = 0, \ldots X_{k+m} = 0, \mu = \mu^{(i)})}{1-\lambda_j(1 \mid X_k = 0, X_{k+1} = 0, \ldots X_{k+m} = 0, \mu = \mu^{(i)})}$$

where, j subscripts over the N respondents in the data set, and
$(X_k, \ldots X_{k+m})$ is a mutually exclusive set of dichotomous covariates.

For continuously measured covariates we calculate the average hazard ratio using:

(A2-2) $$hazard\ ratio_{i,k} = \frac{1}{N}\sum_{j=1}^{N}\frac{1-\lambda_j(1 \mid X_k = X_k + \theta, \mu = \mu^{(i)})}{1-\lambda_j(1 \mid X_k = X_k, \mu = \mu^{(i)})}$$

where, θ is an arbitrary offset. For the hazard ratio corresponding to age, we set $\theta = 5$ years.

Also, we calculate the baseline hazard of viaticating at each time period,

(A2-3) $$baseline\ hazard\ rate_i(t) = \frac{\exp(\lambda_t^{0(i)})}{1+\exp(\lambda_t^{0(i)})} \quad t = 1\ldots9 \text{ years.}$$

We repeat 100,000 iterations. Finally, we calculate the mean and standard deviation of (A2-1)-(A2-3) over all the iterations, which we report in Table 4.

Figure 1: Budget Constraint when Terms of Trade Favor the Viatical Settlements Market

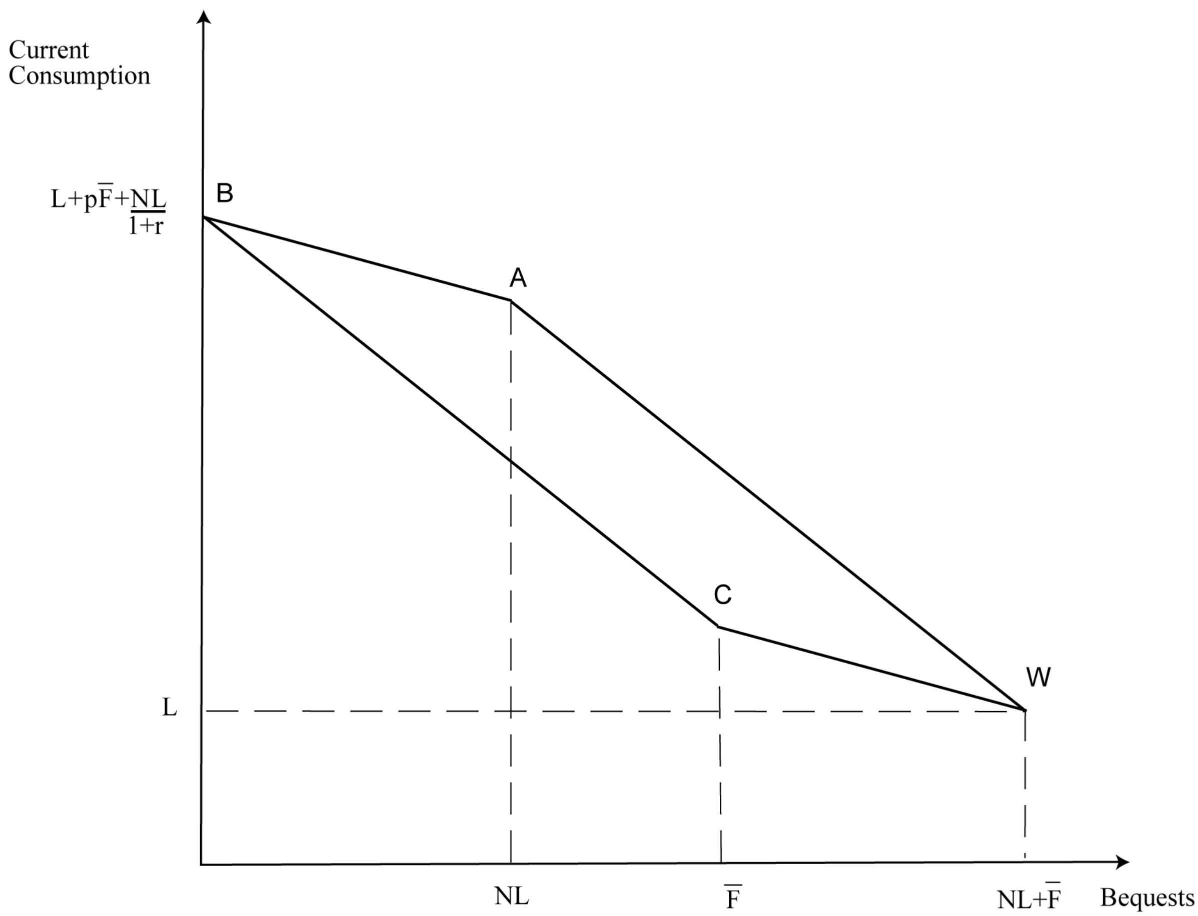

Figure 2a: Increasing Mortality Risk and the Supply of Life Insurance for H_1 Consumers

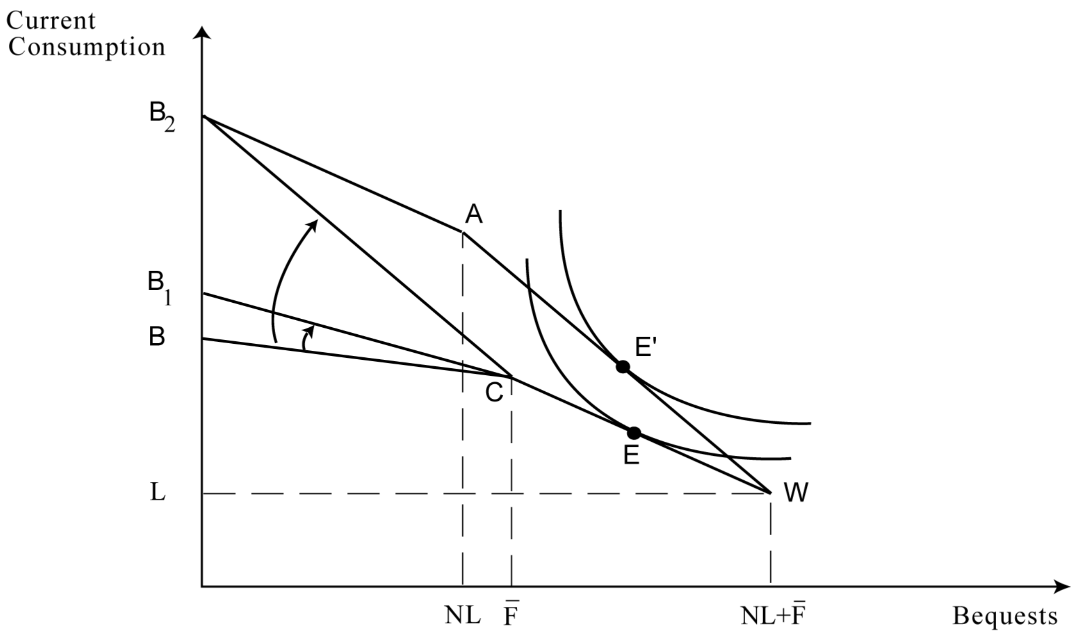

Figure 2b: Income Effect Dominates Substitution Effect

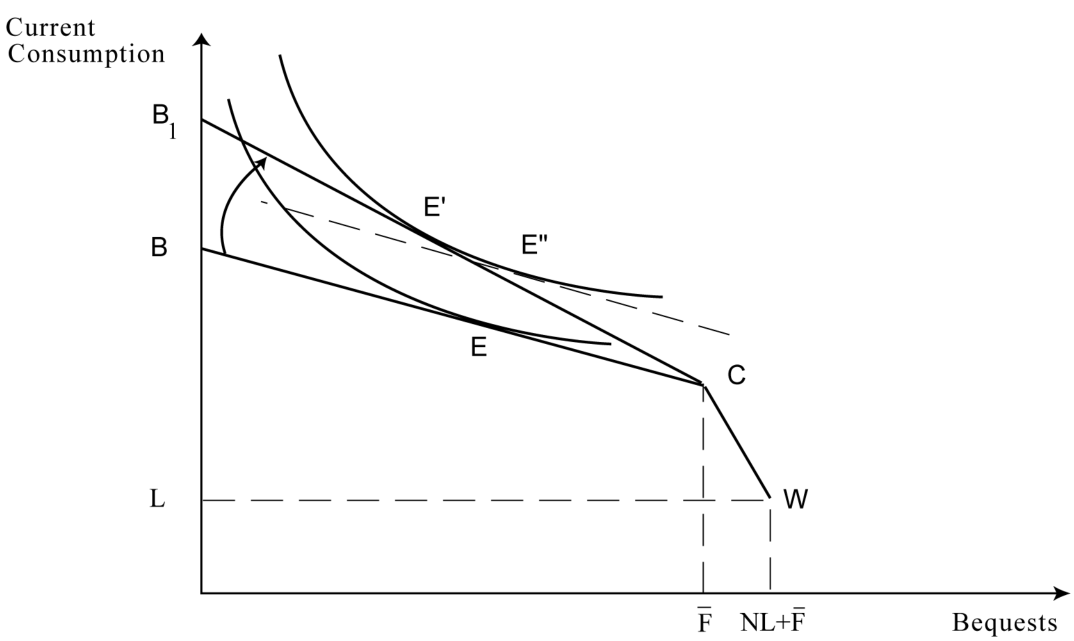

Figure 3. Increasing Mortality Risk and the Supply of Life Insurance for H_3 Consumers

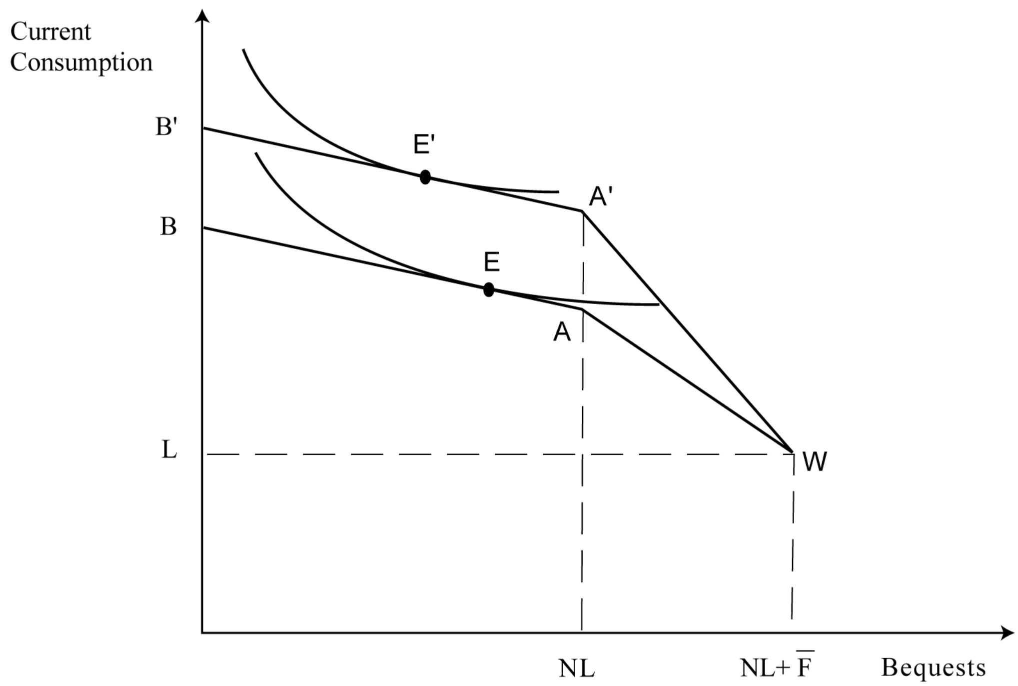

Figure 4a: Increasing Non-Liquid Assets and the Supply of Life Insurance by H_1 Consumers

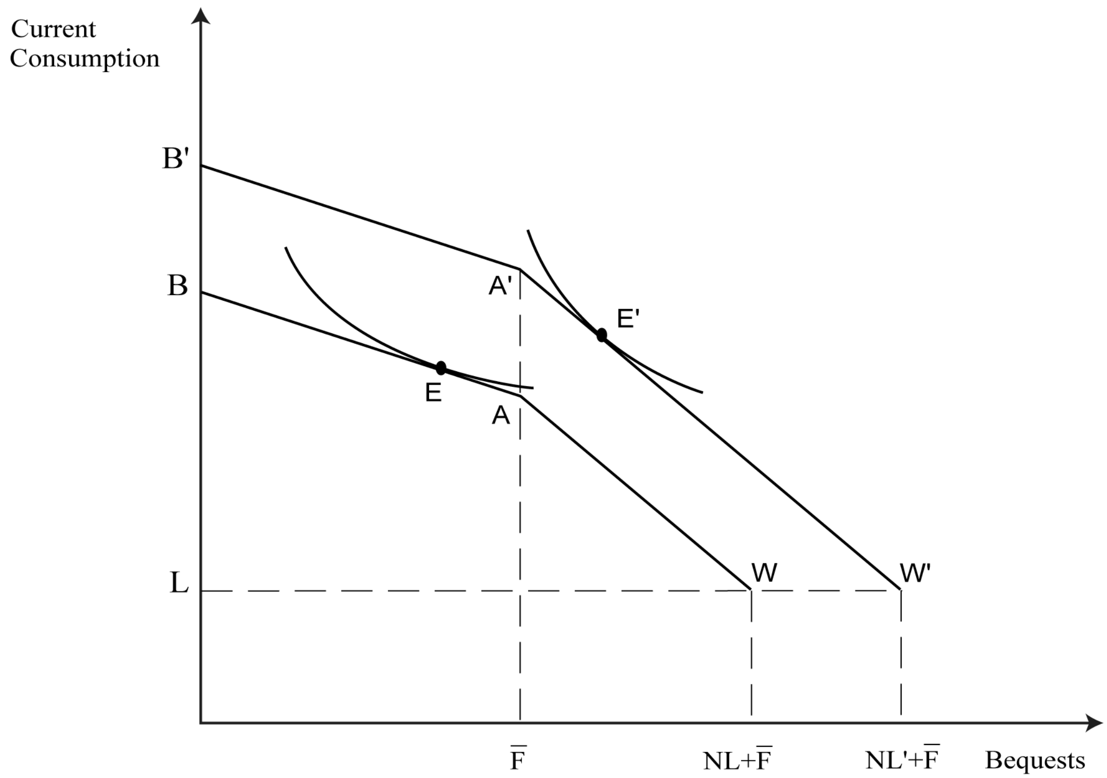

Figure 4b: Increasing Non-Liquid Assets and the Supply of Life Insurance by H_3 Consumers

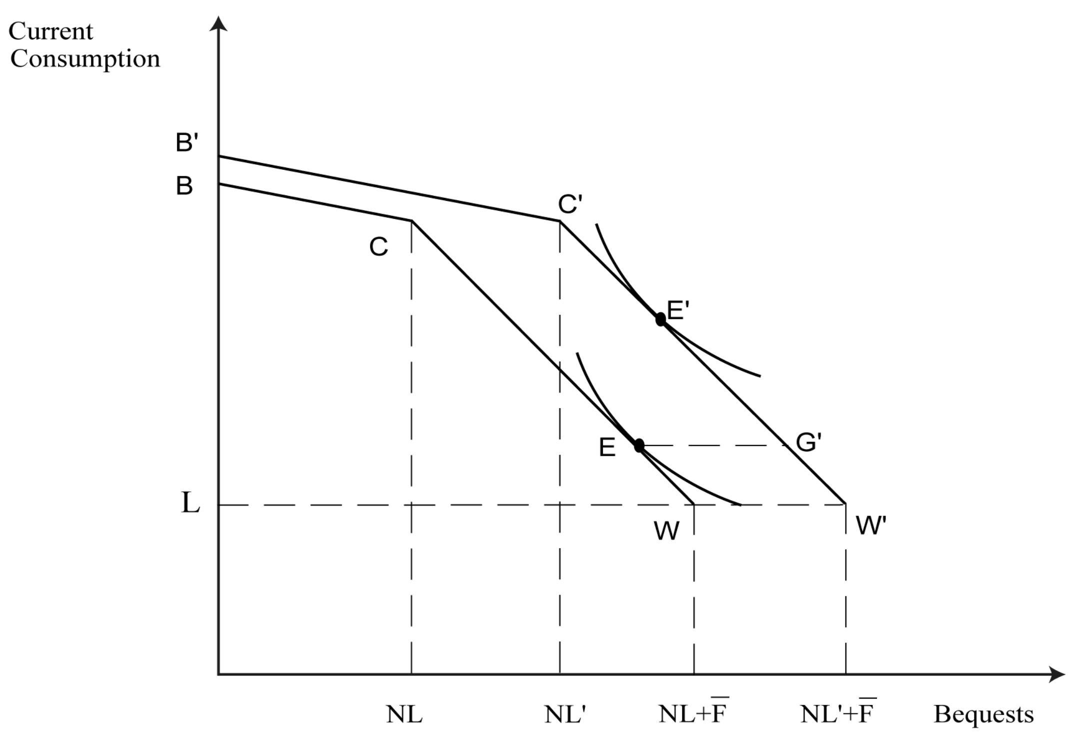

Figure 5a: Possible Separating Equilibrium with Negative Bequest Effect

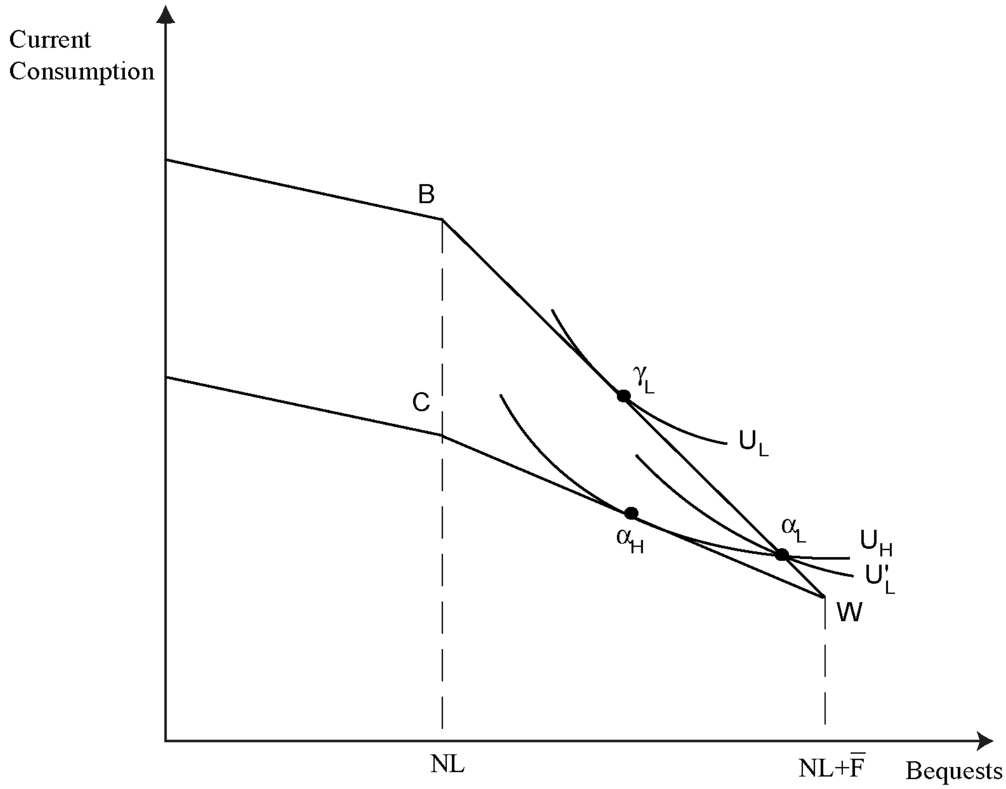

Figure 5b: Possible Separating Equilibrium with Positive Bequest Effect

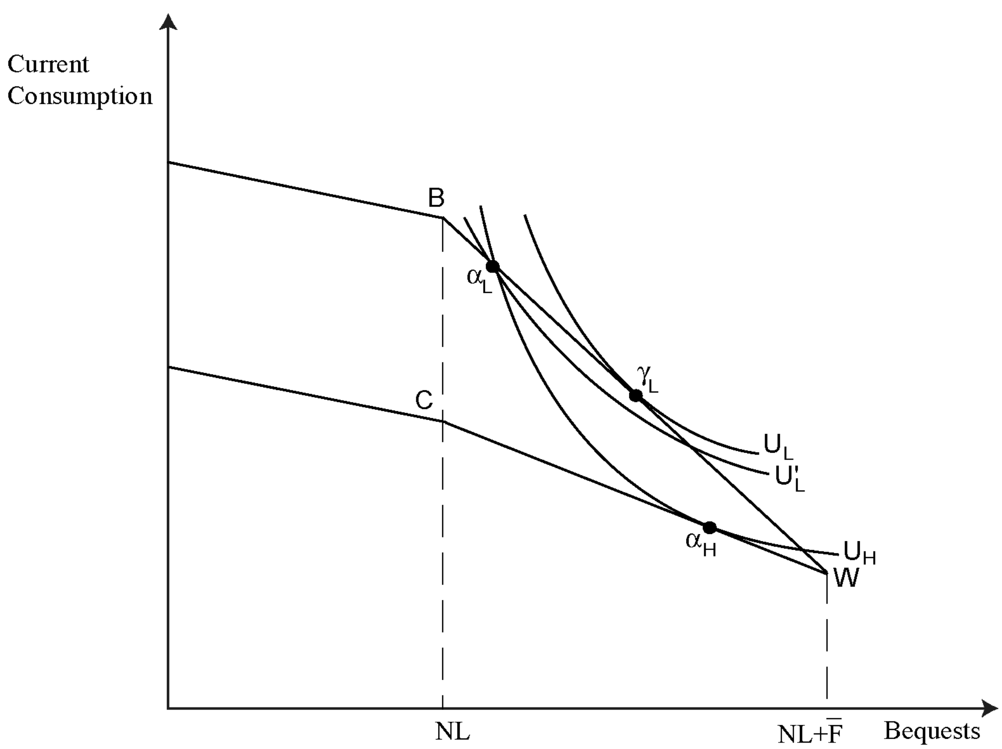

Figure 6: Proportion Not Viaticated by Health Status and House Ownership